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PERSISTENCE OF CHLORINATED HYDROCARBON INSECTICIDES IN TURF TREATED TO CONTROL THE JAPANESE BEETLE

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When DDT, chlordane, and other chlorinated hydrocarbon insecticides are applied as top dressings to established turf for control of larvae of the Japanese beetle (Popillia japonica Newm.), the persistence of the residues is an important factor governing the length of time the treatments are effective. Experimental results indicate that some of these residues remain insecticidally active for several years, but little information has been published on the amount of these residues present at various intervals after treatment.

Schread (11) reported that DDT applied to turf at the rate of 25 pounds per acre controlled larvae of this insect after 30 months; toxaphene at the rate of 20 pounds per acre and chlordane at the rate of 8 pounds per acre were effective after 18 months. Fleming (2, 3, 4) and Fleming and Maines (6, 8) found that DDT at the rate of 25 pounds per acre was generally effective in controlling these larvae for at least 5 years; toxaphene at this rate and chlordane at the rate of 10 pounds per acre were effective for at least 3 years. Fleming and Maines (7) demonstrated that TDE at the rate of 25 pounds per acre was less effective than DDT in reducing populations of this insect in turf. Later they showed that the insecticidal action of TDE persisted after 3 years.

Smith (12) demonstrated that DDT was stable in acid and alkaline soils, and after 18 months recovered 95 percent of the DDT applied. Foster (9) found no significant loss of DDT in four cultivated soils in cold frames during 4 years. Cullinan (1) reported that DDT and chlordane were stable in soil and that the latter showed a fungicidal or fungistatic action; toxaphene broke down under certain conditions, evidently being destroyed by the soil bacteria or fungi.

Beginning in 1944 experimental turf plots from 1/4 acre to several acres in size were established in different areas where larvae of the Japanese beetle were sufficiently abundant so that the effectiveness of several chlorinated hydrocarbon insecticides against this insect could be studied. DDT was applied in 1944 at Totawa, N.J.; in 1946 at Blairstown, N.J., Northampton, Mass., and New London, Conn.; in

1947 at Blairstown and New London and at Orange, Conn.; and in 1948 at Moorestown, N. J. Toxaphene and TDE were applied in 1947 at Blairstown, New London, and Orange. Chlordane was applied in 1947 at Blairstown, New London, Orange, Moorestown, and at Deerfield, Mass., and in 1948 at Moorestown and at Philadelphia, Pa. Aldrin and dieldrin were applied in 1949 at Blairstown and Philadelphia.

In most of the experiments the insecticides were applied in the form of dilute dusts by means of a fertilizer spreader, but in a few experiments they were applied as suspensions or emulsions with an hydraulic sprayer. In this report no differentiation is made between the various formulations. The turf was mowed and cared for according to the usual practice at the golf course, college, academy, or parkway where the plots were located.

In 1948 and 1949 a few samples were taken from the Moorestown plots for chemical analyses, and in the fall of 1950 samples were taken from all the plots for chemical analyses[1/] and bioassays. Each sample was a composite of 100 borings, each 2 inches in diameter and 3 inches in depth, taken systematically over the treated area. Previous analyses had shown that all the chlorinated hydrocarbon insecticides applied as top dressings to established turf had remained within the first 3 inches of soil.

The total organic chlorine in the samples was determined by the method developed by Koblitsky and Chisholm (10), except in those samples containing aldrin and dieldrin, where the amount of organic chlorine was considered to be too low for satisfactory analyses. The soil and the debris were analyzed separately. The amounts of the toxicants, expressed as pounds per 3-inch acre, were calculated by multiplying the total organic chlorine by the following factors: DDT 2.0, TDE 2.256, chlordane 1.56, and toxaphene 1.46.

Bioassays were made with third-instar larvae of the Japanese beetle and with adults of Macrocentrus ancylivorus Roh. according to the procedures described by Fleming, Coles, and Maines (5). The amount of toxicant in the debris determined chemically was added to the amount in the soil determined biologically to obtain the total concentration.

In all, 98 chemical analyses and 190 bioassays with Popillia and 235 with Macrocentrus were carried out with these samples. The averages of the determinations, rounded off to the nearest 0.5 pound, are presented in table 1.

1/ The chemical analyses were made by R. D. Chisholm and L. Koblitsky, of the Division of Insecticide Investigations.

Table 1.--Results of chemical analyses and bioassays of residues in turf treated with several chlorinated hydrocarbon insecticides

Insecticide	Average amount applied per acre	Period after treatment	Residue per 3-inch acre		
			Chemical analysis	Bioassay	
				Popillia	Macro-centrus
	Pounds	Months	Pounds	Pounds	Pounds
DDT	25.5	30	21.5	25.5	22.0
		40	19.5	22.5	19.0
		52	13.0	10.5	9.5
		76	7.0	5.5	7.0
	31.0	52	12.0	18.0	12.0
	35.5	76	13.5	18.0	12.5
	60.5	30	56.5	55.5	53.5
TDE	26.5	40	13.0	10.5	-
Toxaphene	26.0	40	12.0	10.0	13.5
Chlordane	10.0	4	9.0	-	-
		18	3.5	-	-
		28	.5	.5	2.0
		30	1.0	1.0	3.0
		35	2.5	2.5	3.5
		40	2.0	1.0	2.0
	19.5	4	16.5	-	-
		18	4.3	-	-
		30	2.5	1.0	2.0
Dieldrin	3.0	12	-	2.0	2.0
Aldrin	3.0	12	-	1.0	1.0

In general there was close agreement between the amounts of the residues determined chemically and biologically. This agreement suggests that the composition of the residues did not change significantly in the turf. This comparison could not be made with aldrin and dieldrin because no chemical determinations were made of the residues.

Since these turf plots were in widely separated localities, over a distance of about 250 miles, the treatments were subject to variable factors of soil type and weather. The composite data may be considered as representing the average persistence of these toxicants within this area.

The results of the chemical and biological determinations from the DDT and chlordane experiments were averaged for each time-concentration combination and expressed as the percentages remaining of the insecticide originally applied. These percentages were then plotted against the periods of weathering, and free-hand curves were drawn through the points, as shown in figure 1. For DDT the curve was of the sigmoid type, showing that the loss of this insecticide took place slowly for about 3-1/2 years, then rapidly, then more slowly again. The percentage of both DDT and chlordane loss was about the same in plots receiving widely different amounts of toxicant.

Almost half the decrease in the DDT residues occurred during the fourth and fifth years after application. After 6 years about 30 percent of the DDT remained, and the rate of decrease was then so slow that it was expected that some of this toxicant would be present in these plots for several additional years.

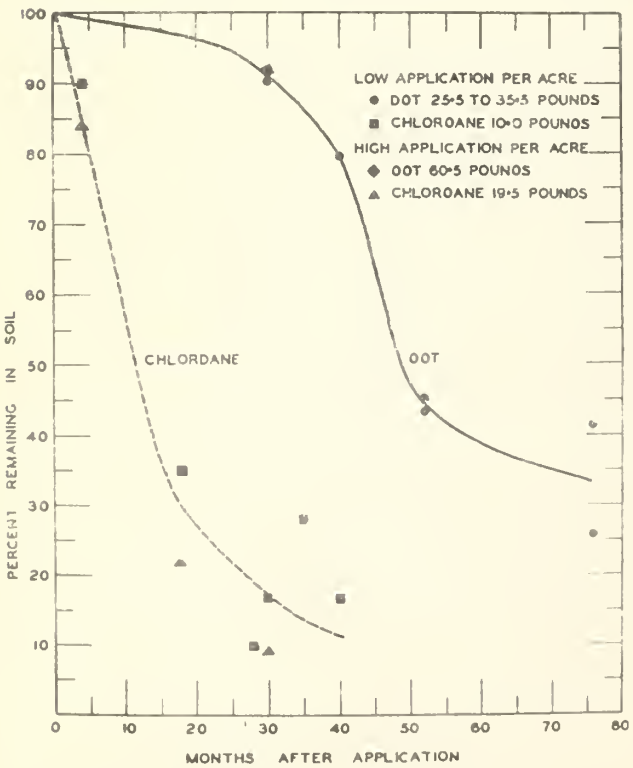

Figure 1.--Loss of DDT and chlordane from exerimental turf plots.

Chlordane decreased more rapidly than DDT and after 1-1/2 years only about 30 percent remained in the turf. Below this point the decrease could not be determined definitely, since the amounts of the residue were within the limits of accuracy of the chemical and biological methods. It was expected that traces of chlordane would persist in these plots for several more years.

The studies of residues of TDE, toxaphene, dieldrin, and aldrin have not been under way long enough to permit a final estimate of the persistence of

these toxicants in turf. However, losses of 56 percent for TDE and 54 percent for toxaphene were recorded after 40 months, and of 33 percent for dieldrin and 67 percent for aldrin after 12 months.

It is assumed that the loss curves for these materials are also sigmoid in shape, but more observations are needed to establish their exact nature.

Summary

The persistence of various chlorinated hydrocarbon insecticides applied to turf for control of larvae of the Japanese beetle (Popillia japonica Newm.) was determined by means of bioassays and chemical analyses of the treated turf. In the bioassays larvae of Popillia japonica and adults of Macrocentrus ancylivorus Roh. were used as the test insects. The turf samples were taken from treated plots in eight localities in Massachusetts, Connecticut, New Jersey, and Pennsylvania.

The close agreement between the chemical and biological determinations of residues of DDT, TDE, toxaphene, and chlordane suggests that the composition of these toxicants did not change significantly while they were in the turf.

The percentage loss of DDT and chlordane in the turf was usually much the same in plots receiving widely different amounts of toxicant. The chlordane decreased more rapidly than the DDT--to 30 percent of the amount applied in 1-1/2 years whereas this percentage of DDT still remained after 6 years. After 40 months 46 percent of the toxaphene and 44 percent of the TDE remained, and after 12 months 67 percent of the dieldrin and 33 percent of the aldrin.

Literature Cited

(1) Cullinan, F. P.
1949. Some new insecticides--their effect on plants and soils. Jour. Econ. Ent. 42: 387-391.

(2) Fleming, W. E.
1948. Chlordan for control of Japanese beetle larvae. Jour. Econ. Ent. 41: 905-912.

(3) _____
1950. Persistence of effect of DDT on Japanese beetle larvae in New Jersey soils. Jour. Econ. Ent. 43: 87-89.

(4) _____
1950. Protection of turf from damage by Japanese beetle grubs. U.S. Dept. Agr. Leaflet 290, 8 pp.

(5) Fleming, W. E., L. W. Coles, and W. W. Maines
1951. Biological assay of residues of DDT and chlordane in soil using Macrocentrus ancylivorus as a test insect. Jour. Econ. Ent. 44: 310-315.

(6) _____ and W. W. Maines
1947. The effectiveness and duration of treatments with technical DDT in different soils against larvae of the Japanese beetle. U.S. Bur. Ent. and Plant Quar. E-716, 20 pp. [Processed.]

(7) _____ and W. W. Maines
1950. Effectiveness of TDE against the Japanese beetle. U.S. Bur. Ent. and Plant Quar. E-804, 8 pp. [Processed.]

(8) _____ and W. W. Maines
1951. Experiments with toxaphene against the Japanese beetle. U.S. Bur. Ent. and Plant Quar. E-821, 9 pp. [Processed.]

(9) Foster, A. C.
1951. Some plant responses to certain insecticides in soil. U. S. Dept. Agr. Cir. 862, 41 pp.

(10) Koblitsky, L., and R. D. Chisholm
1949. Determination of DDT in soils. Assoc. Off. Agr. Chem. Jour. 32: 781-786.

(11) Schread, J. C.
1949. Residual activity of insecticides in control of turf insects. Jour. Econ. Ent. 42: 383-387.

(12) Smith, M. S.
1948. Persistence of DDT and benzene hexachloride in soils. Ann. Appl. Biol. 34: 494-504.